

DOCUMENT RESUME

ED 260 809

PS 015 278

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TITLE Microcomputers, LOGO, and Young Children: Building a Powerful Environment.
PUB DATE Nov 83
NOTE 39p.; Paper presented at the Annual Conference of the National Association for the Education of Young Children (Atlanta, GA, November 3-6, 1983).
PUB TYPE Viewpoints (120) -- Speeches/Conference Papers (150)
EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS *Cognitive Processes; Cognitive Style; Early Childhood Education; *Learning Experience; *Microcomputers; *Perception; Social Behavior; Teacher Role; *Young Children
IDENTIFIERS *LOGO Programing Language

ABSTRACT

Assuming that computers will be part of programs for young children, this paper initially describes skills children exhibit in play at computers, provides a scenario of a child's first encounter with a computer, and offers a rationale for including computers in young children's programs. Subsequent material describes the LOGO computer language, supplemented with printouts of computer commands and graphic outputs. A rationale for the use of LOGO by young children and their teachers is provided, and ways LOGO facilitates the development of cognitive and perceptual skills are described. Concluding brief remarks offer suggestions to teachers about beginning their involvement with computers. (RH)

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MICROCOMPUTERS, LOGO, AND YOUNG CHILDREN:

BUILDING A POWERFUL ENVIRONMENT

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Paper presented at the National Association for the Education of Young Children
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MICROCOMPUTERS, LOGO, AND YOUNG CHILDREN:**BUILDING A POWERFUL ENVIRONMENT**

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Shall We Use Computers with Young Children?

Whether microcomputers should be used with young children will be debated for years to come. People rightly question whether young children are able to use a computer or whether computers are physically, psychologically, or socially harmful. Many believe that microcomputers are only an expensive toy that is not a high priority for our young child programs. The reasoning is; "We will not have computers, so we can ignore them." This is the most dangerous position that we can take. Because the cost of microcomputers is still dramatically decreasing and their popularity is steadily increasing, microcomputers will be part of young child programs. The question should not be; "Will we have a computer," but rather, "What will we do with our computers." Assuming there will be computers makes our task harder. Young child educators must determine what children can do and judge what they should best be doing.

Can Young Children Use Computers?

Young children can and do use microcomputers in preschools, child care centers and homes. These young computer children are able to do a variety of computer activities that are necessary in any computer learning environment. They see information on a

screen and decipher meaning. Children make meaningful responses by finding and pressing appropriate keys (Reed, 1983; Zeiser, & Hoffman, 1983). Young children seem to enjoy delving into areas on their own for which, adults insist, they cannot be prepared.

Skills needed for young children's computer play. For the present, children must be able to follow the visual directions given on a television or monitor screen or orally from a speaker. In the future, computers may communicate by other means; perhaps even tactually through computer assisted teddy bears. Children quickly learn to read selected picture codes and words that are important to the task and get them where they want to go. They may practice a special command many times, always delighting in the outcome. Then, they are off to find how other computer words are used. Children stick with an activity because the motivation to explore the computer environment is very strong.

Young children must be able to choose from lists of choices to do activities; for instance, drawing, building, music, picture story writing, etc. They need to be able to handle cassettes and floppy diskettes, carefully locate them, pull them from their wrappers, and place them into a disk drive. These tasks become as commonplace as eating crackers or pouring juice for young children.

Children's First Computer Encounter: A Scenario

A computer was set up in a preschool for the first time and a Logo program called *Instant* was prepared. *Instant* is a

simplified version of some of Logo drawing commands. It is perfect for the very young or as a primer for novice computer users. With a few commands, very exciting designs can be made. This keeps the very young or the very new interested while they also learn some key presses. The following is a description of what happened in one preschool.

The children began to drift in from Together Time. The first few children came right over to me. Veronica, a little girl, asked, "What are you doing?" "Drawing pictures with the computer," I said. She wanted to try. I explained that pushing the "F" key made a line go forward and that pushing the "L" key made the turtle turn. I moved out of the way, and Veronica started pushing keys. Another girl, Emily, sat down next to Veronica, and three or four other boys and girls gathered around to see what was going on. They began to ask questions and to give Veronica suggestions. ... I stood back while they all tried to crowd in around the keyboard. The children began to get very excited and kept shouting different instructions to Veronica. "Turn!" "R! R!" "Turn now!" (Zeake, Billingham, & Price, 1982).

Rather than promoting nonsocial behavior in children, the computer is seen here as a rallying banner for language use, problem solving and reasoning, and social interaction and cooperation.

Why Should Young Children Use Computers?

Society fears microcomputers. Some people fear that the asocial computer does not offer a suitable environment for young children. They fear that children will become attached to the computer or to some software, rather than exploring other children and adults in their environment. Again, children surprise us, but they shouldn't. Children behave as socially at a computer as they do in a sandbox. They share, imitate and check other's actions. They talk and argue. It makes little difference whether they are at the computer center or playing with blocks in the block corner. The intense play in order to learn continues.

Microcomputers offer intense practice. Young children like to practice and revel in their newly acquired skills. These skills are often related to body motions or body control; skipping, block building, or winking. Many young children would also find joy in playing with numbers or words, but they are less graspable to them. These concepts are a step removed from the grand body world that children know so much about. A microcomputer can allow numbers and words to be nearly as close to one's reality as are blocks.

The computer can allow young children to practice identifying numbers, letters, and words in a playful way. Children are able to play with letters and words on the screen, for instance, their names or new words they have just learned. Numbers, groups, and other math concepts are also candidates for easy screen play. The computer environment can help a child to

play in an entirely new domain, one that exercises communication and symbol skills.

Microcomputers are also very good at allowing young children to draw and play with music, areas for which they are not yet totally skillfull. Young children want to draw shapes, but are unable to. The computer gives the child the power and satisfaction to place predrawn figures or one's own figures on the screen. Young children know melodies long before they can sing them. With the help of a computer, young children can have the opportunity to create those melodies they try so hard to sing.

Controlling a microcomputer is controlling power. Computers offer a new, exciting, and fast tool for transferring information. A person can transform information into personal knowledge. In a technological, service based society, knowledge and its transport is equivalent to power. Capital is no longer measured in tons, but in kilo-bytes. Computers offer more people the opportunity to have more knowledge with less monetary investment than any commodity since the land rush days. The microcomputer has the power to become the great democratizer, allowing more communication of information among people, over an unbiased network, than ever before. The microcomputer also has the potential to deepen the gulch between those who hold power and those who will never have it. The difference between those who will be in control and those who will be controlled lays in who controls information and knowledge; and therefore the

computer.

Accessability is a microcomputer's primary strength. Access to computers is nearly universal, but control also requires computer knowledge. Those who shun the computer or let others deal with it will lose their chance to change the direction of computer use. Personal involvement with computers will lead to computers that satisfy our needs. Computers are not innately good or evil, they are just powerful tools that we may use to work for us or allow to be used for others.

Microcomputers offer a two mode experience. The computer that most of us think of is very rational and steady. It acts and reacts to our symbolic language. This computer is a slave to our left brain hemisphere, the hemisphere that is the control center, in most people, for language, reason and other serial processes. This is the center for most school experiences and for a learning style that Seymore Papert calls "obsessive" or "hard" (Inael, 1983). These learners plan their problems and attack them systematically. Hard learners enjoy structured lessons and classrooms. Not all learners react to problems as hard learners. Those who do not are inclined to shun traditional hard education.

There is another side to computers that we have all seen, but may not have recognized. This is the energetic, emotional computer. This computer acts and reacts to our emotional excitement, our sense of harmony and beauty. It is part of the motivation for the game player, but it is also the motivation

for the problem solver. In fact the game player is a kind of problem solver. Papert calls learners that prefer this side of the computer, "hysteric" or "soft" learners (Isaacs, 1983). The soft learner is interested in directly engaging a problem. These learners do something first and then look at the results. They actively involve themselves in a process that leads towards a solution.

Neither hard nor soft learners are better problem solvers or are more creative, but hard learners have an easier time in traditional classrooms than do soft learners. Computer environments that are highly sequenced and structured favor the hard learner also. The next section will describe an environment that requires neither a hard nor soft learner, but welcomes either equally.

Logo: A Language to Control Your Computer

Logo is an extremely accessible language for controlling a computer (see Abelson, 1982; Abelson, & diSessa, 1982; Burnett, 1982; and Papert, 1980 for a complete background and description of Logo). It is embarrassingly easy to have successful experiences with Logo, especially when you consider the difficulty people have with less friendly and less powerful languages. The inviting Logo environment helps children and adults to get started using a computer and Logo's power keeps them excited beyond the first steps. The combination of accessibility and power allows people to gain control over the computer and keep it.

Control is the first step toward solving problems. Once control is established by the person, rather than the computer, the person must actively think-out the next step. One's mental stuff is activated and brought to bear on the immediate problem. Contrast this with the image of a user performing a rote task that the computer has sequenced. This person is reacting to the computer. The computer is in control.

Building Logo tools for skill practice. There are times when one wants to use a computer to be a drill instructor; to learn letter names or number facts, for instance. It is possible to use Logo to create the procedures to do this. Commercial drill software can be purchased also, but I am convinced that it is better to build one's own software tool. A software tool can be built for a specific purpose and person, and modified for a different purpose or person. Most current software does not allow one to modify its offering. There are advantages to creating software that one can use as a tool or building block. Building software tools is especially powerful when the user builds them for herself to use and modify. When a computer user is also a tool builder, one's relationship to the computer environment changes. The computer becomes another in the class of teacher tools that include; pencil, marker, glue, paint, and poster board.

The software builder/user sees the drill software as a learning tool that can be changed if it is not right. The builder/user thinks about the software's methods for

presentation and his own responses to that presentation. The typical drill software user is concerned with getting a score and getting done and not much with learning or thinking. Because the tool builder can change a presentation he is thinking about the learning process, he is pushing for the novel, creative, or more challenging experience. Commercial drill software does not include the option to tailor the program and, thus, removes this crucial learning element from the experience.

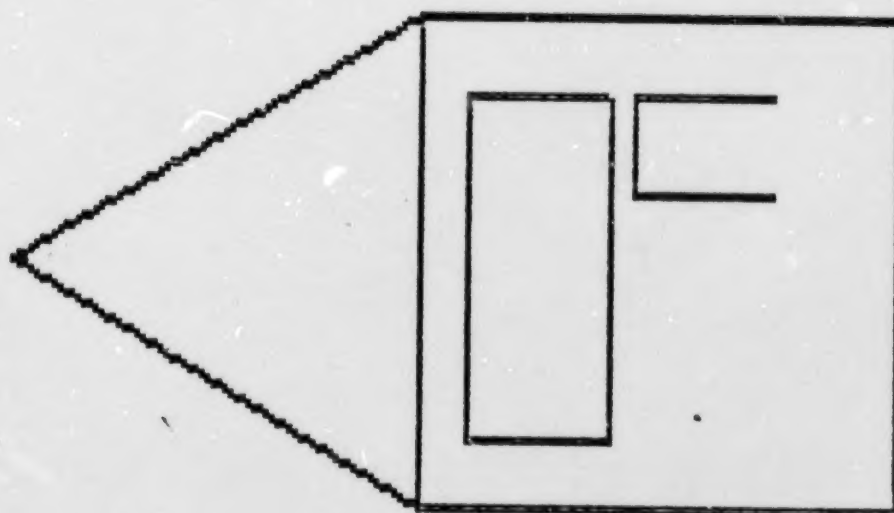
Logo tools for creation. Most of the time one will want the computer to help students create rather than to instruct. With the help of Logo, the builder/user can use a set of software tools to help create visual patterns, pictures, music, word games, stories, and so on. Creating games, stories, or art objects is a process that has no set finish, so builder/users learn to create and re-create many times. Each new version is an attempt at a new problem solution. New solutions are tried, not because other solutions were bad or wrong, but because something has been learned about the problem by building it, that leads to a new problem.

An example of building a software tool in Logo. Logo's problem solutions are based on the procedures used to get from an unsolved to a solved state. A simple example will illustrate. Say the problem is to build a HUMAN.SQUARE in the center of the dance floor. The problem tells us to start at the CENTER.OF.THE.FLOOR, which is our first procedure. Next we must

form a HUMAN.SQUARE. For our SQUARE procedure, let's assume that a LINE procedure can be made from two people, holding hands. Then four LINE procedures are needed to make the SQUARE procedure. The SQUARE can then be formed by placing a LINE at the center of the floor. Then placing another LINE at a right angle to the first. Position a third LINE at a right angle to the second and a fourth LINE at a right angle to the third. That's it, so stop. The problem is solved. The procedures "CENTER.OF.THE.FLOOR," "LINE," and "SQUARE" were used to make a HUMAN.SQUARE at the center of the dance floor.

Words are the Tools of Logo

Logo, at its most elementary level, is a world of dynamic pictures. The star of every picture is a robotic turtle that is sometimes mechanical, but most often she is a blip of light, but either way, the turtle can move numbers of steps and always knows in what direction she will go. The words FORWARD and RIGHT are the basics of the turtle's vocabulary. With these two command words, the user can control the turtle to draw wonderfully fanciful and also serious pictures. Following are examples.



1. Type this ...

DRAW

FD 70

RT 90

FD 70

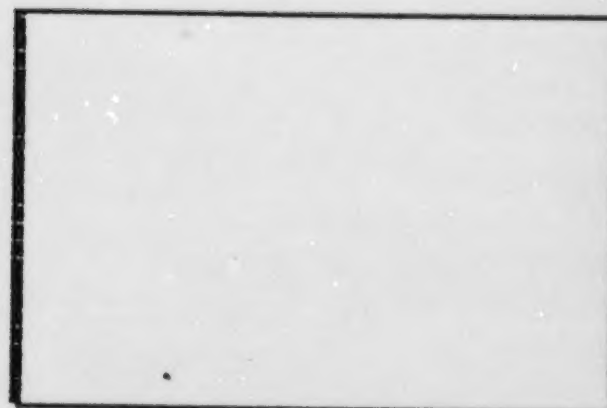
RT 90

FD 70

RT 90

FD 70

RT 90



Box

2. Type...

DRAW

FD 50

RT 120

FD 50

RT 120

FD 50

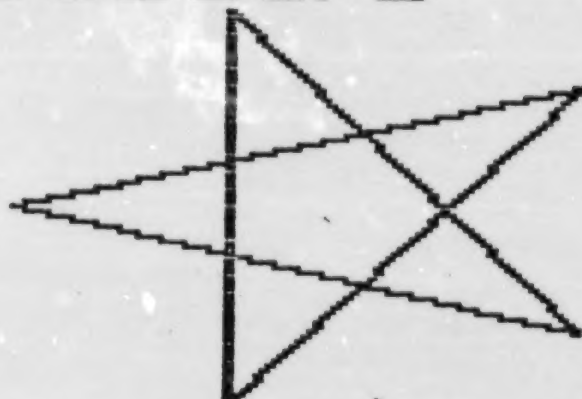
RT 120



Triangle

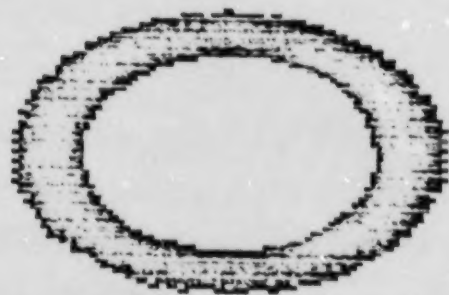
Repetition and control in Logo. All computer languages have ways to repeat tasks and ask control questions. Logo uses the word REPEAT for repetitive tasks and IF-THEN questions for control. Following are examples of Logo words and the pictures they create. (If you are a Logo novice, see if you can predict what each procedure does.)

3. STAR Procedure



```
TO STAR  
  REPEAT 5 [FORWARD 100  
            RIGHT 144]  
END
```

4. DONUT Procedure



```
TO DONUT  
  REPEAT 90 [FORWARD 50  
              RIGHT 89]  
END
```

SQUARESIDE

```
TO SQUARESIDE :SIDES  
  IF :SIDES < 1 THEN STOP  
  FORWARD 50  RIGHT 90  
  SQUARESIDE (:SIDES - 1)  
END
```

SQUARESIDE 2



The power of lists in Logo. Not all Logo words draw pictures. In fact the great majority of Logo words are for arithmetic and writing. Logo's greatest power lies in the way it handles characters, words, and sentences. For Logo, unlike most computer languages, both single numbers and letters are in the same class called characters. Groups of characters are words and groups of words are sentences or lists. This scheme is very near the hierarchical relation of characters, words, and sentences in English and is easy to follow. The following examples will help demonstrate how Logo uses lists. (Try to predict the outcomes of the following Logo procedures.)

CLASS.LIST

MAKE "CLASS.LIST
[SUE TOM AMIR]

PRINT FIRST :CLASS.LIST

- SUE

PRINT LAST :CLASS.LIST

- AMIR

NUMBERED.LIST

```
MAKE "NUMBERED.LIST  
  [[1 SUE] [2 TOM] [3 AMIR]]
```

```
PRINT FIRST :NUMBERED.LIST  
- [1 SUE]
```

```
PRINT LAST (FIRST :NUMBERED  
.LIST)  
- SUE
```

Access to Your Computer's Power

Some languages make it hard to access some of the neat things your computer may do. For instance, my computer has a voice synthesizer. Logo allows me to make new words so that I can use this board easier in Logo than I can from other languages, including the one it was designed for. If your computer has special graphics or music hardware, then Logo helps you make new and easily used words to make use of it. This is a bonus and another reason to make software tools from the Logo language.

Why Should Young Children and Their Teacher's Use Logo?

Logo offers the raw material to build tools for children's learning. Children learn in a rich and varied environment, one that's filled with pots to clang; string to pull; balls to throw; bugs to catch; sand to feel; carrots to taste; and places to jump. Children also learn from environments they build in their minds as they test nature's environment. Tools for mind building are not as readily available as blocks and other tools for sensory perception. Children must continually modify their thinking to be consistent with their increasing knowledge about how objects fall, float, or break, but their thinking often goes untried and untested unless they have an object (e.g., mud, sand, block, etc.) that can be actively explored. It is not as easy to explore some concepts as it is to explore mud. Computers and Logo can be used to make these concepts more mud-like, so that children can

explore concepts that can be held in one's head, but not in one's hand.

Logo is a flexible and easy to use computer language for exploring one's thinking. For example, Logo makes it easy to explore old words and create new ones and it plays with the great ideas of space and time and makes them child sized. Most of all Logo, it is extremely accessible to both children and teachers, but at the same time is extremely powerful. The power of Logo has not been tapped as yet by teachers or most of their students. I wish to offer the beginning of an extension of Logo that offers software tools for teachers and their young charges to use and build upon. The next section describes possible learning tools for young children made from the raw language of Logo.

Logo Tools for Young Children

There are two broad skill areas for which mind tools can be made available to young children; Cognitive skills and Perceptual skills. Cognitive skills include problem solving, math, and language. Perceptual skills include seeing, hearing, and elements of time.

Cognitive Process Tools

Problem solving tools. Problem solving skills are a part of children's lives, but are usually not well formed for young children. Tools are necessary to help children formalize questions and generate probable answers. The greatest tool for problem solving is the language itself. Great discoveries are

made and problems are solved with every Logo procedure created. Other helpful tools would develop the abilities to formulate guesses or hypotheses about outcomes, test hypotheses, and design new problems and novel solutions. In practice these are games or tasks that ask the questions; "What comes next?" "Am I done yet?" or "How else can I arrange these?"

Tools for math skills. Although Montessori and Cuisinaire have developed physical objects to help children conceptualize math concepts, children are still held responsible for the mental consolidation of these physically based concepts. Logo tools are suggested that will help bridge the gap between sticks manipulated by hand and mental images manipulated in one's head that are necessary to do arithmetic. The bridge occurs by placing images on the screen that, though similar to physical manipulable objects, are moved a step away from the hand, and a step toward one's mental operating space.

The kinds of skills that may be practiced with these tools are similar to the basic concepts we wish young children to attain: seriation, classification, measurement, number, number facts, weight, etc. On their face, these tools would look similar to objects that can be touched, but since they are not, the child must supply a mental touch to objects that are only screen images.

Tools for language skills. Traditional language materials all suffer from their static display. Computers offer a dynamic feature to language symbols that we have never had

except in traditional story telling and drama. The dynamic display helps focus viewers attention on important areas of the screen. With traditional media, the teacher never knows what children are focusing on; do they see the intended word or are they instead looking at a letter, or worse yet at some spurious punctuation. The magic of animation, highlighting, text separation, and other video tricks can be employed easily in the computer environment. Tools for language should help children to use symbols and markers, to recognize signs and words, and most importantly, to play with new words.

Children observe, compare, and classify many four legged animals before deciding on a firm definition for "doggie." Children must also observe and compare many words before their use and definition can be meaningful. New and made-up words are very important to young language explorers who need to test all aspects of what makes a word a word.

Logo is a perfect environment for grammar play. It is very easy to make simple tools that help someone to explore a root word and its prefixes or suffixes. Tools that play with parts of speech are also trivial. For instance the child supplies the subject and the computer supplies the predicate. The child can toss away poor subject predicate examples and keep good ones. The result can be children's first story or poetry writing. The tools help the child user go beyond what would have occurred without the cognitive help that the computer can provide.

When it is time for story telling to advance to story

writing, Logo provides a simple word processor. When it is easy to write and rewrite, mistakes are less traumatic. More care is given to the message and less to the writing of the message. The ability to communicate is increased and more concern for the audience can be given.

Perceptual Skills

Tools for seeing. Unlike the printed page, the video screen can have moving pictures and words. This movement helps ease children into making sense of 2-D space. Shapes look more like real objects when they move. Words look more like those on cards or posters when they are isolated. Information tables have more meaning when words can be highlighted.

Design is the placing together of simple objects into a unique and/or aesthetic juxtaposition. A basic design element is the line. Logo tools could include line generating tools that would help children explore the line element. The most elementary line exploration tool would simply randomly place a line on the screen at the explorer's command. Gradually, the line explorer would want to control the length and position of lines; Then line color. These tools and others are easily added. For instance, more specific parameters can be controlled; eg, nearness to the center of the screen, size, number of total lines, number of different colors, etc.

Tools for hearing. The two broad categories of hearing are speech and music. Speech adds an important input channel to one's computer experience regardless of age. Other than speech

sounds can be used for warning or welcome signals or explored for their interest. Sound matching games can be created or sounds can be used as markers (rather than physical tokens) in board-like games to increase one's discrimination.

Music novices sense music as built from a set of musical phrases. Musical phrases are similar to sentences in written language. Eventually, with some experience, it is clear that the phrases are constructed from individual notes, but like learning language, it is not obvious where one note leaves off and another begins. By exploring musical phrase and its relationship to composition, one naturally and eventually finds a method to notate musical phrases. Sometimes this discovered notation is similar to standard notation, but even if it is not, the explorer knows what notation must consist of and accepts standard notation with greater ease.

Logo's structure makes it easy to explore musical phrases. Individual notes can be assembled into lists or sentences that emulate a musical phrase. The list of notes is now a single entity or chunk with which children can explore musical pieces that are larger and more meaningful than individual notes.

Tools for time elements. At the heart of music, dance, drama and visual art and also in geometry and architecture is a sense of time created by its pulse and rhythm. The temporal nature of one's work is hard to explore outside of the computer world because our representations are stopped in time. But in the computer world, time is dynamic and under explorer control.

Whether one is drawing a house or composing a melody, the feeling of time is an important variable that can be experienced through Logo.

Where Should a Teacher Start?

I have been emphasizing the importance of active participation in a computer environment to take advantage of children's natural exploration. I suggest that this approach is also the one for adults to follow. Find a Logo computer and begin playing. Experience what the play means to you. Once you have a personal base of computer experience, then ask yourself what else you want to do. The answers to this question will lead you to Logo and computer resources that are quickly becoming available. These resources include books, magazines, schools, libraries, computer clubs, scout troops, church groups, etc.

Adult involvement toward a personal computer understanding is necessary before we can understand what children really want and what they really mean. It is not good enough to say that only bright children can use computers. My observations and other evidence (Weir, 1979) has been to the contrary. Regular and slow children seem to achieve to heights of skill and confidence while working in a Logo environment. Teachers also learn how their children are thinking by watching young computer users solve new problems (NOVA, 1983; Weir, 1979). A nearly illiterate boy at The School of the Future in New York in describing his experience with Logo could only say that "Logo

has been very good to me" (NOVA, 1983). His increasingly sophisticated Logo projects told a story that his language as yet could not. Logo has been very good to me also and it might be very good to you and your children.

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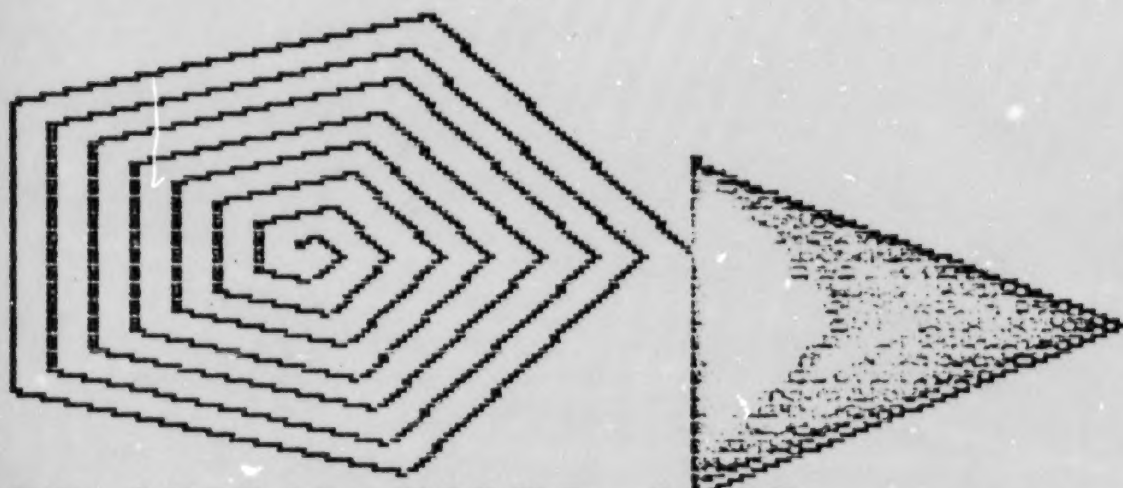
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HUMAN.SQUARE

TO HUMAN.SQUARE
Center.Of.Floor
Square
END

TO Square
REPEAT 4 [Line]
END

5. SPIRAL procedure



```

TO SPIRAL :SIDES :STEP
  FORWARD :STEP
  RIGHT ( 360 / :SIDES )
  SPIRAL :SIDES :STEP + 2
ENT

```

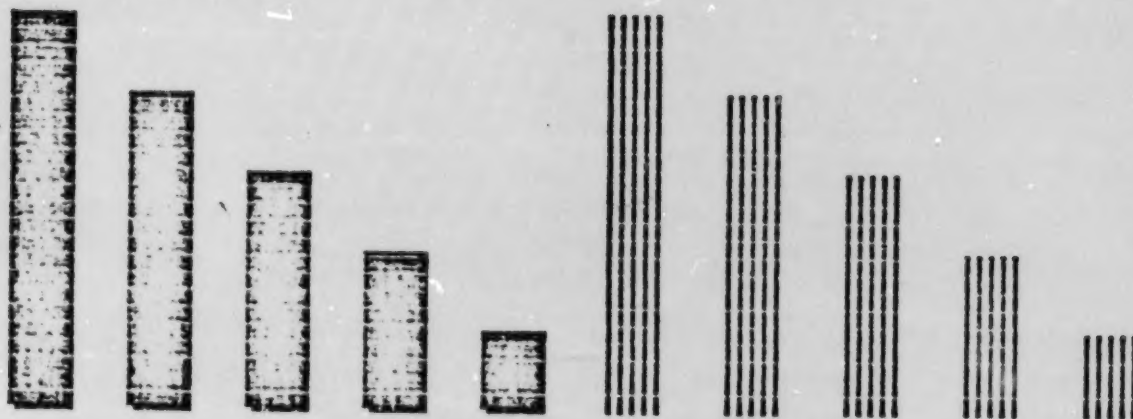
6. Text

```
TO NEWFISH :NAME  
  PRINT WORD :NAME "FISH  
END
```

What new fish are made by...

```
NEWFISH "CAT  
NEWFISH "DOG  
NEWFISH "COW
```

27



MAKING SENTENCES

1st Part

2nd Part

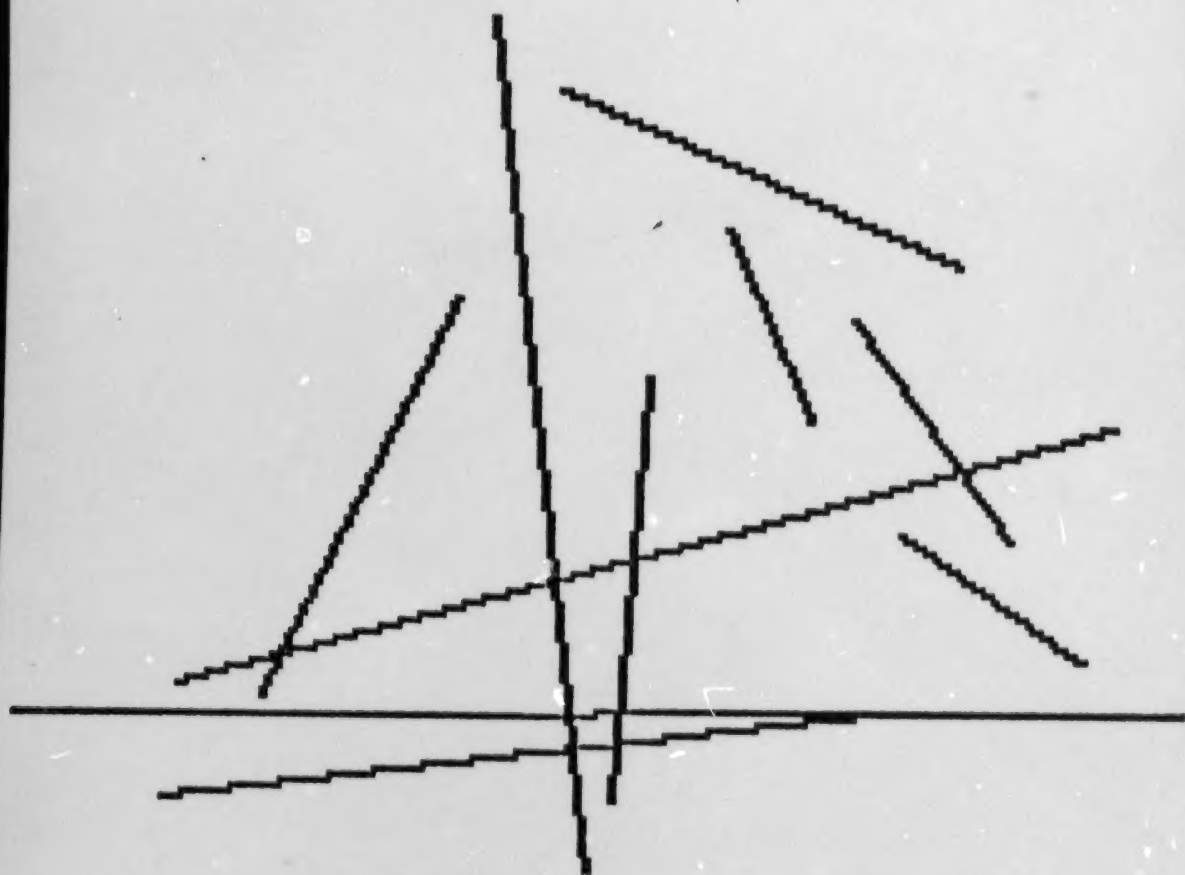
Mark



1. is tired.

2. walks home.

3. has a ball.



RHYTHM STICKS



Rain. Rain. Go a-way.



Come a-gain some oth-er day.

PHRASE PLAYER

Choose a song: [A, B, or C]

Your choice is C

You can make your song.

Choose from C [1 2 3]